Experiment Proposed to Test the Relativity of Spatial Concurrence

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Abstract

From the same two famous postulates of relativity, after embracing relativistic non-localization, emerges an alternative formulation of special relativity which explicitly exhibits anisotropic spatial warping and relativity of spatial concurrence in contrast to the relativity of simultaneity and synchronization of the current framework. The new and old frameworks are not mere mathematical alternatives but are experimentally distinguishable. The new formulation also opens the doors to new exciting relativistic phenomena not explored so far. This paper, the sixth in the series of rudiments of relativity revisited, the previous one and the next propose an array of experiments to distinguish between the two relativistic physics. Relativity of spatial concurrence or of simultaneity are mutually exclusive, the presence of one discards the other and vice versa.

1. Introduction

Current special relativity (CR) deduces relativity of simultaneity (RoS) [1,2] while the new relativity (NR) deduces the relativity of spatial concurrence (RSC) as RoS is deemed as an undesired effect (UE) of finite signal speed (FSS) and a source of self-contradictory transformed time of the CR by Kishori's second axiom [3-4]. Further in [3-6], an alternative framework of relativity is developed, which besides the two famous postulates of relativity also complies with Kishori's axioms, reproduces the so far verified results of relativity, and predicts new ones like anisotropic spatial warping (ASW) and RSC, and relativistic non-localization (RNL). The new transforms [NT] derived in [5] are produced here along with the Lorentz transforms (LT).

NT: $x' = em(x - vt)\ ,\ y' = em_\perp y\ ,\ z' = e\, m_\perp z$ (1)

$t' = e\, t\ ,$ (2)

LT: $x' = g(x - vt)\ ,\ y' = y\ ,\ z' = z$ (3)

$t' = g\,(t - vx/c^2)\ ,$ (4)

where,

$e = \sqrt{1 - v^2/c^2}\ ,\ m = \frac{1}{1-(v/c^2)(x/t)}\ ,\ m_\perp = em\ ,$

$m' = \frac{1}{1+(v/c^2)(x/t)}\ ,\ m'_\perp = em'\ ,\ g = 1/e\ ,$ (5)

v is relative velocity between frames and c is the lightspeed. The main differences of NT and LT are the absence of synchronisation term in (2) and presence of m factor in spatial transforms, responsible for effects like ASW, RSC, RNL [3-5].

CR and NR, and thus the LT and NT, differ mainly in their physics of mapping the events of one frame to the other as they map the same set of input events to two different sets of events in the other frame. CR assumes a photon to be relativistically localized at an overlapped position in different frames (OPDF), while the NR asserts its different positions in different frames (DPDF) due to relativistic non-localization (RNL). CR based on the OPDF maps a set of simultaneous events to a set of non-simultaneous events giving rise to RoS, while NR based on the DPDF maps the same input events to a set of simultaneous events in the other frame, giving rise to RSC. RoS and RSC are mutually exclusive like OPDF and DPDF. Which then follows the true relativistic physics? This can neither be decided through arguments nor through the so far proven results of relativity. New tests in the wake of new development are needed. Therefore, an array of new experiments has been proposed [7-11] including this one in this series of rudiment of relativity revisited.

2. RSC versus RoS

Consider a particle moving on a very long ruled scale as shown in fig 1. To read its position at any time we look for its spatial concurrence with the ruling marks on the scale at that particular time. '*This spatial concurrence is relative*' *is the revolutionary claim made by NR, termed as* RSC.

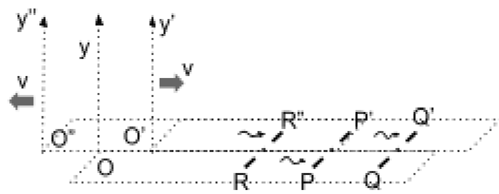

Fig 1. If a photon is detected at P in the rest frame, it is detected at Q' in O' frame and at R" in the O" frame.

Let the origins of three frames, *O, O'* and *O"* coincide at the time of emission of a sharp burst of photons at $t=t'=t''=0$, fig 1. While the photon is detected at *P* in the rest frame (RF), it is detected at *Q*' (not *P'*) in the moving frame (MF) *O'* at that instant owing to RSC. To a first order approximation from (1) and (2)

$$PQ = vx/c \qquad (7)$$

where *v* is the relative velocity of the MF w.r.t the RF [4]. This linear order effect of (7) is quite measurable and testable. To further widen this gap of detection, consider another MF *O"* having the same relative speed *v* but in opposite direction and a detector installed in this frame would detect the photon say at *R"*, a point concurring with *R* in the RF, giving a gap in positions of detection as

$$RQ = 2vx/c \qquad (8)$$

Direct fall out of RSC is that at a given instant, the same particle exists at DPDF which are not mutually agreeable on the basis of the overlaps of their frames at that instant. When a photon is at *P* in the rest frame, at that instant the same photon is at *Q'* (not at *P'*) in the *O'* MF, and at *R"* in the *O"* MF. This DPDF goes against the very premises of the CR called RoS, which assumes the existence of the photon at OPDF. Because two simultaneous blasts in the rest frame can occur at different times only when the moving frame observer (MFO) forces the position of the photon in his frame at an overlapping point in the rest frame, and vice versa. This is also called overlapped positions syndrome (OPS) of CR. Thus DPDF is related to RSC as inherently as OPDF is related to RoS. From this point of view concept RoS and RSC are mutually exclusive, i.e. acceptance of one results in the rejection of the other, and vice versa, as shown below.

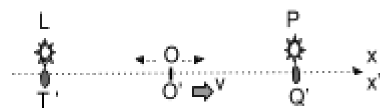

Fig 2a. Two photons start off at O to blast P and L points of the rest frame.

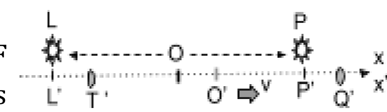

Fig 2b. Photons reach at P and L to and produce blast at t in the rest frame.

Two photons originate at the common origin at $t=t'=0$ (fig 2a), and reach the points P and L at time *t* to trigger in the RF two simultaneous blasts as shown in fig 2b. By then the MF shifts to the right to align its new points *L'* and *P'* with the blast-sites of the RF. For MFO, the photon to be at *P* has to be at *P'* as well, and at *P'* it reaches earlier there for MFO by an amount *vt/c* than what RFO claims. Similarly, for MFO the other photon can not be at *L* to trigger the blast without being at *L'* of its frame and hence the blast at *L* is delayed for the MFO. So to claim non-simultaneity in the MF frame of the two simultaneous blasts of the RF or vice versa, one requires the positions of the photon in both the frames to overlap with each other. Thus, RoS is not possible without the OPDF. Now consider another moving frame *O"*, moving to left with *v*. At the time of blasts, its point *P"* concurs with *P* of the RF, so photon has to be at point *P"* as well to trigger the blast at *P* and for the MFO of *O"*, it will take longer to be at *P"* than what the RFO claims, making for him the blast at *L* to go before the blast at *P*.

Thus, the OPDF of a photon leads to RoS of CR. For all three frames, the photon exists at overlapping points P, P' and P'' of the three frames when it blasts at P. The photon can not approach P in the RF without approaching P' in the MF, and it can not be at P of the RF without being at P' for the O' frame. So, for O' frame, the time of the photon to reach at P' becomes the time of the blast at P. Similarly for frame O'', the time of the photon to reach at P'' becomes the time of the blast at P in the RF. They end up not agreeing with each other's claims about the timing and order of the two blasts due to their belief in the OPS.

The moment these observers give up OPDF and allow different positions of the photon in different frames, their disagreement on timing and order of the blasts melts away. Because then RFO may reply to the MFO of O': yes photon did reach at point P' in the O' frame at an earlier time but it doesn't mean it was then also available at the overlapped position P in the RF to trigger the blast. MFO's estimation of the timings, order or non-simultaneity of the blasts would have applied, had it set the triggers or blasts at its points P' and L' of its own frame. But this time, they are set at P and L in the RF and so the simultaneity prevails. Because, when the photon was at P in the RF it was at Q' in the MF, and similarly when photon was at L in the RF it was at T' in the MF, accounting for the same time lapses for the two blasts. One may ask what difference it makes if the detectors and blasts are at P of the RF or P' of the MF, because at the time of the blast, the two points overlapped. NR replies that it is the state of motion of the detectors, which is different in the two cases and that affects the position of detection of the photon in the two frames. When the photon is at P', it is not there at P and vice versa. This explains how the RSC of NR deems the RoS unessential and how the RoS of CR deems the RSC unessential.

We derived eq (7), which is the statement of RSC, from the NT by interpreting its temporal transform as invalidity of RoS which is fair as they do not contain any synchronisation term. Similarly by interpreting the temporal transform (4) of LT, as a validity of RoS due to the explicit presence of synchronisation term, which is interpreted as such by the CR, LT deduce the shift in the positions of existence of the photon in the different frames to be, $PQ=PR=0$, which is a statement of OPDF or OPS of CR. However, if we do not interpret (4) of LT as a statement of RoS, i.e. if LT's transformed time t' is not taken as the MF time corresponding to the instant t, i.e. if RSC of the NR is accepted, then eq (7) can be deduced from LT as well, and vice versa. Thus the experiments proposed in this paper distinguish between the CR and NR, and their interpretations of their respective transforms, rather than the transforms themselves.

2. The proposition

It is proven beyond doubt that for CR, a photon is detected at overlapping positions P' and P'' in the two moving frames when it is detected at P in the rest frame, and this OPDF leads to RoS or vice versa. And for RSC of the NR, when the photon is detected at P it must not be available at P' and P'' for detection in the respective frames, but at Q and R as shown in fig 1, and this DPDF leads to this RSC or vice versa. In RSC, motion-state of the detector affects the detected position and by setting different detectors in different states of motion, we can determine if DPDF or OPDF. prevails. In the next section two experimental setups are devised, one to test the OPDF, and the other one to test the DPDF.

As a precaution it is recommended to maintain vacuum throughout the path of the photons from emission to detection because it is not known how air or other medium affects the RNL-superstate of the photons. If RNL-state collapses before detection then RSC will disappear.

3 Experiments to test RSC

Two stations K1 and K2, separated apart and having no relative motion with each other, together form our rest frame, fig 3. K1 has an extremely sharp pulsed laser at O to emit a pulse to be detected later at a time t, precisely at P on station

K2. *OP=x=ct*. The plane of emission of the pulse is the yz plane through *O* and the plane of detection is a plane parallel to the *yz* plane passing through *P*, call it the plane of stationary detection (PSD). The detectors with an ultra fast electronic shutter can operate for a very short duration to sense the presence of the pulse at a given position.

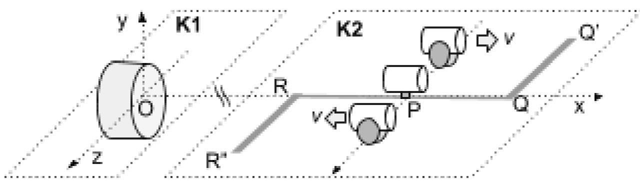

Fig 3. Basic setup to test relativity of spatial concurrence.

In addition to the fixed detector let us have a set of two moving detectors (MD) on K2, which are otherwise identical to stationary counterparts except being on wheels (or levitated). The two MDs form the two MFs moving in the opposite direction with speed *v* w.r.t the RF. Finally to achieve a spatially localized detection we rely on spatially limited electric paths shown as gray strips *QQ'* and *RR"* that momentarily turn on the MD's ultrafast shutter on their arrival on the strip so that to sense the presence of pulse at the position of the gray strip. Additionally detectors are capable of recording the time of detection of the pulse, however spatially limited detection frees us of some stringent requirements to compare time.

3.1 Experiment A: Initially mount the MDs along PSD in K2, moving away from PSD on either side, and the gray strips are moved about *vx/c* distance apart from PSD on either side, see setup of fig 3. In the stationary frame when pulse reaches PSD at time *t* to be detected by stationary detector (SD) at *P*, moving detectors moving at a velocity *v* will be at gray strips *vx/c* distance apart from PSD on either side and triggered. All three detectors though apart from each other must detect the pulse at their respective locations to prove RSC, confirming the presence of pulse at DPDF, not concurrent with each other. The positive outcome of this experiment validates the RSC and DPDF of the NR, and refutes the OPDF and RoS of the CR .

Alternatively, instead of using a detection-window using strips, we can measure the position of detection of the pulse by the two moving detectors in the opposite direction and compare the gap with *2vx/c*, ignoring second and higher order effects. Non zero gap between positions of detection of two oppositely moving detectors with velocity *v* that compares with *2vx/c* confirms the RSC and DPDF. Needless to say that we need a pulse-width << *2vx/c* and detection speed of detectors faster or at least comparable with the pulse-width for these experiments to rule out OOW of time and confirm OOW of space.

3.2 Experiment B: This time mount the moving detectors *vt* distance apart from PSD on its either side, approaching PSD with a speed *v*. The gray strips in this setup are laid along PSD so that when MDs arrive at PSD their sensing window is set on, as shown in fig 4.

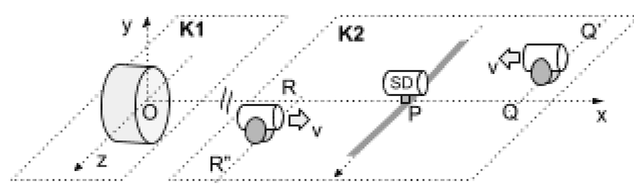

Fig 4. Setup to test overlapped position syndrome.

At the time *t* when pulse will be at *P* in the RF, the moving detectors will cross the gray strip laid along the PSD, thereby triggering them to sense the pulse precisely at PSD. Effectively, all three detectors (one stationary and two moving) are aligned along PSD at time *t* when pulse reaches PSD in the stationary frame and the gray strip along PSD ensures that moving detectors are also triggered to sense the pulse there. Owing to RSC, while photon is very much present in the RF at PSD to be detected, it must not be at PSD for the MDs. If MDs fail to detect any pulse at PSD while the stationary detector detects the pulse there unfailingly, then it invalidates OPDF and RoS. Positive detection at the PDS by all three detectors invalidates the RSC and DPDF, and validates the OPDF.

6. Conclusion

Even if the two formulations of relativity, one deducing RoS and the other deducing RSC are equivalent, they need to be explored because it gives a chance to understand how two different concepts can explain all the relativistic aspects, and so none of RoS and RSC is indispensable for relativity. However, they are not equivalent, and at least our six papers [7-12] including this one, in the series of rudiments of relativity revisited, propose many experiments to show that the two formulations are experimentally distinguishable. In [13] different interpretations of LT and NT are compared, and in [14] NT are extended to static fields.

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